

WHAT IS CLAIMED IS:

- 1 1. A semiconductor wafer processing system, comprising:
  - 2 a reactor for processing at least one semiconductor wafer;
  - 3 at least one load lock coupled to the reactor; and
  - 4 a magnetically coupled linear servo-drive mechanism located
  - 5 within the at least one load lock to transfer wafers to and from the
  - 6 reactor, the servo-drive mechanism including
    - 7 a carriage for holding a wafer;
    - 8 a driven magnet array within the carriage;
    - 9 a guiding mechanism for guiding the carriage linearly,
    - 10 a cylindrical tube housing a linear actuator and isolating the
    - 11 actuator from a wafer environment in the load lock, the driving
    - 12 magnet array inside the cylindrical tube and mounted to an output
    - 13 of the linear actuator, the driving magnet array magnetically
    - 14 coupled to the driven magnet array mounted within the carriage;
    - 15 an engine coupled to the actuator to drive the actuator, and
    - 16 a controller coupled to the engine to control the engine for
    - 17 optimizing transfer times and controlling acceleration.

- 1 2. The system of claim 1, wherein the reactor uses chemical vapor
- 2 deposition.

- 1 3. The system of claim 1, wherein the first magnet array includes

2 permanent magnets that are radially aligned within the carriage and  
3 have alternating polarities.

1 4. The system of claim 3, wherein the actuator comprises:  
2 a shaft coupled to a pulley system, the pulley system coupled to  
3 the engine; and  
4 a nut coupled to a second magnet array, the second magnet array  
5 includes permanent magnets arranged radially and having alternating  
6 polarities, the nut coupled to the shaft such that the nut moves axially  
7 along the length of the shaft when the shaft rotates.

1 5. The system of claim 4, wherein the first magnet array includes at  
2 least two magnets having opposite polarities.

1 6. The system of claim 5, wherein the second magnet array has the  
2 same number of magnets as the first magnet array.

1 7. The system of claim 1, wherein the guiding mechanism includes a  
2 linear ball slide.

1 8. The system of claim 1, wherein the cylinder is non-magnetic.

1 9. The system of claim 1, wherein the shaft is a ball screw shaft.

1 10. A magnetically coupled linear servo-drive mechanism for use in a  
2 load lock of a semiconductor fabrication system, comprising:  
3 a carriage;  
4 a guiding mechanism for guiding the carriage linearly;  
5 a cylinder housing an actuator, the actuator magnetically coupled  
6 to the carriage;  
7 an engine coupled to the actuator to drive the actuator; and  
8 a controller coupled to the engine to control the engine for  
9 optimizing transfer times and controlling acceleration.

1 11. The magnetically coupled linear servo-drive mechanism of claim  
2 10, wherein the carriage includes a first magnet array.

1 12. The magnetically coupled linear servo-drive mechanism of claim  
2 11, wherein the first magnet array includes permanent magnets that are  
3 radially aligned within the carriage and have alternating polarities.

1 13. The magnetically coupled linear servo-drive mechanism of claim  
2 12, wherein the actuator comprises:  
3 a shaft coupled to a pulley system, the pulley system coupled to  
4 the engine;  
5 a nut coupled to a second magnet array, the second magnet array

6 includes permanent magnets arranged radially and having alternating  
7 polarities, the nut coupled to the shaft such that the nut moves axially  
8 along the length of the shaft when the shaft rotates.

1 14. The magnetically coupled linear servo-drive mechanism of claim  
2 13, wherein the first magnet array includes at least two magnets having  
3 opposite polarities.

1 15. The magnetically coupled linear servo-drive mechanism of claim  
2 14, wherein the second magnet array has the same number of magnets  
3 as the first magnet array.

1 16. The magnetically coupled linear servo-drive mechanism of claim  
2 10, wherein the guiding mechanism includes two guide shafts.

1 17. The magnetically coupled linear servo-drive mechanism of claim  
2 10, wherein the cylinder is non-magnetic.

1 18. The magnetically coupled linear servo-drive mechanism of claim  
2 10, wherein the shaft is a ball screw shaft.

1 19. The magnetically coupled linear servo-drive mechanism of claim  
2 13, further comprising a four-axis gimbal between the nut and the

3 second magnet array.

1 20. A method for linearly translating a wafer in a semiconductor wafer  
2 fabrication system, comprising:

3 placing a wafer on a carriage;

4 magnetically coupling an actuator to the carriage, the actuator

5 isolated from a vacuum environment; and

6 translating the actuator linearly with controlled acceleration, which

7 in turn translates the carriage, holding the wafer, linearly due to the

8 magnetic coupling.

1 21. The method of claim 20, wherein the translating includes  
2 optimized motion.

1 22. A device for linearly translating a wafer in a semiconductor wafer  
2 fabrication system, comprising:

3 means for placing a wafer on a carriage;

4 means for magnetically coupling an actuator to the carriage, the  
5 actuator isolated from a vacuum environment; and

6 means for translating the actuator linearly, which in turn

7 translates the carriage, holding the wafer, linearly due to the magnetic  
8 coupling.